



AD-A154 204

AD NO. 2  
TECOM PROJECT NO. 3-WE-100-DIV-023  
REPORT NO. USACSTA-6188

FINAL REPORT  
INERTIAL NAVIGATION SYSTEM - LAS II  
FOR SGT YORK TESTING

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U.S. ARMY COMBAT SYSTEMS TEST ACTIVITY  
ABERDEEN PROVING GROUND, MD 21005-5059

APRIL 1985

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January to April 1985

Prepared for:  
U.S. ARMY TEST AND EVALUATION COMMAND  
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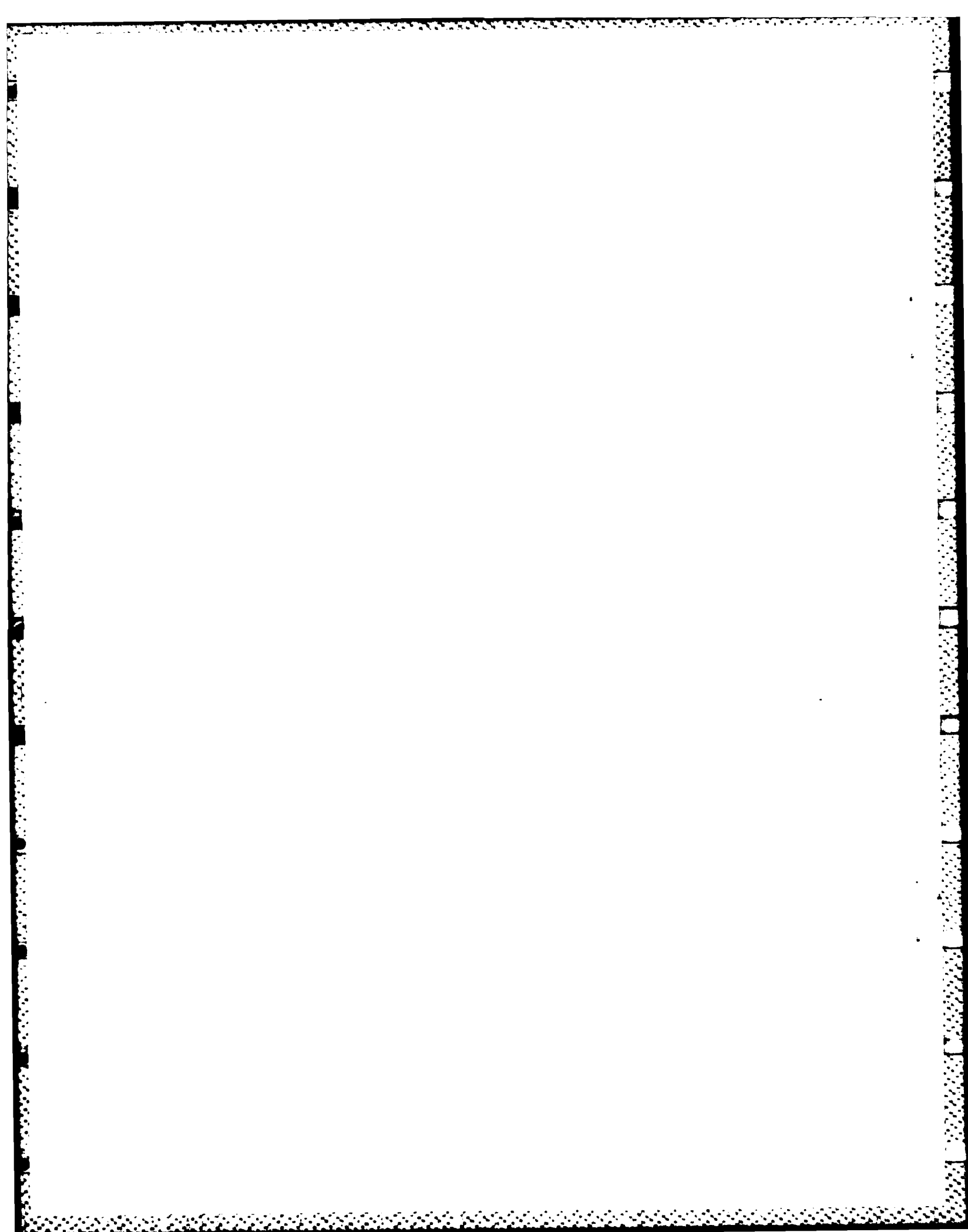
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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM	
1. REPORT NUMBER TECOM Project 3-WE-100-DIV-023	2. GOVT ACCESSION NO. <b>1154 204</b>	3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) INERTIAL NAVIGATION SYSTEM - LAS II FOR SGT YORK TESTING		5. TYPE OF REPORT & PERIOD COVERED Final, January to April 1985	
7. AUTHOR(s) W. Scott Walton		6. PERFORMING ORG. REPORT NUMBER USACSA-6188	
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Combat Systems Test Activity ATTN: STECS-DA-I Aberdeen Proving Ground, MD 21005-5059		8. CONTRACT OR GRANT NUMBER(s) Not available	
11. CONTROLLING OFFICE NAME AND ADDRESS Commander, TECOM ATTN: AMSTE-CM-A Aberdeen Proving Ground, MD 21005-5055		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Not available	
14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office) None		12. REPORT DATE April 1985	
		13. NUMBER OF PAGES 8	
		15. SECURITY CLASS. (of this report) Unclassified	
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE None	
16. DISTRIBUTION STATEMENT (of this Report)  Distribution unlimited.			
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)  None			
18. SUPPLEMENTARY NOTES  None			
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Inertial reference navigation; Gun air defense testing Instrumentation; Target location			
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) An Inertial Navigation System, the LAS II, was tested to determine its feasibility for use in measurement of target position for gun air defense testing. The system demonstrated reasonable accuracy, but is not presently compatible with current analysis hardware and software. <i>None</i>			

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DEPARTMENT OF THE ARMY  
U.S. ARMY COMBAT SYSTEMS TEST ACTIVITY Mr. Walton/mek/298-3711  
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REPLY TO  
ATTENTION OF

STECs-DA-I

29 April 1985

SUBJECT: Final Report on Inertial Navigation System - LAS II for SGT YORK  
Testing, TECOM Project No. 3-WE-100-DIV-023, Report No. USACSTA-6188

Commander  
U.S. Army Test and Evaluation Command  
ATTN: AMSTE-CM-A

1. REFERENCE

Message, AMSTE-CM-A, TECOM, 111910Z, January 1985, subject: Test  
Execution Directive for Special Test on LAS II.

2. BACKGROUND

In most tests of gun air defense systems conducted by U.S. Army Combat Systems Test Activity (USACSTA), the target position is determined with a tracking radar. The use of an inertial reference system, rather than a tracking radar, would be preferable for measuring target positions in several situations. Nap-of-the-earth (NOE) flying and multiple target missions are examples of situations when immunity to ground clutter, multipath problems, electronic countermeasure (ECM) jamming, and use of chaff make an inertial system desirable.

The inertial system used in this test was the Litton LAS II. It is basically a modified PADS inertial reference unit. The PADS is used as a surveying instrument to locate artillery gun positions.

When used as a surveying instrument, periodic stops are made for Zero Velocity Update (ZUPT) every 2 to 5 minutes. The position accuracy when periodic ZUPT's are made is on the order of  $\pm 10$  cm. The accuracy of typical tracking radars is  $\pm 1$  mil in azimuth and elevation, which corresponds to  $\pm 5$  meters at a maximum range of 5000 meters. Laser tracking devices can be an order of magnitude more accurate, but require that a cooperative target be installed on the target aircraft.



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### 3. TEST OBJECTIVES

A test was conducted by the U.S. Army Aviation Development Test Activity (USAAVNDTA) at Fort Rucker to evaluate the feasibility of using the LAS II for air defense testing. Two specific objectives were:

a. Estimate the accuracy of the LAS II when mounted in a helicopter (errors exceeding  $\pm 5$  meters considered unacceptable) in the following conditions:

(1) During normal maneuvers to confirm the general experience observed during use of the PADS inertial system.

(2) During rapid maneuvers that would be encountered during NOE flying.

b. Evaluate the compatibility of LAS II with the Main Analysis Program (MAP) used to analyze the tracking accuracy of gun air defense systems.

### 4. SCOPE

USAAVNDTA will provide a report on the conduct and results of the test. This letter evaluates the compatibility of LAS II with the Main Analysis Program.

### 5. SUMMARY OF RESULTS

The output of the LAS II was recorded by a digital cassette recorder. Post processing was done using an HP-85 desk top calculator and the final smoothed results were provided on a line printer listing. Observations based on the smoothed results of preliminary data obtained during flight tests:

a. When ZUPTs are made every 5 minutes the accuracy is good (1.2 meters or better).

b. When ZUPTs are more than 20 minutes apart, the accuracy is poor. In a 35 minute run, errors of 5.5 meters were noted, in a 45 minute run, errors of 48.8 meters were observed.

c. The three most important runs were made between Cairns Airfield and Hooper Airfield, which is a 17-minute flight. The flights were:

(1) 4 February 1985; normal flight, maximum error = 3.5 meters.

(2) 6 February 1985, AM; flight with NOE maneuvers, maximum error = 4.3 meters.

(3) 6 February 1985, PM; flight with NOE maneuvers, maximum error = 3.3 meters.



## 6. CONCLUSIONS

a. From paragraph 5c, it is concluded that NOE maneuvers do not cause a noticeable change in the accuracy of the LAS II.

b. The accuracy of the LAS II appears to be good enough to warrant further investigation, as long as ZUPTs are no more than 15 minutes apart.

c. As presently configured, the LAS II is not compatible for use with the Main Analysis Program. To become MAP compatible, the following problems must be addressed:

(1) The line printer output presently available is unuseable by MAP. A machine readable output (a formatted 9-track digital tape) is required.

(2) The present offline smoothing process is too slow (50 points processed in 2 hours). The smoothing process should be capable of handling 20,000 points in less than 1 hour. Use of a main frame or minicomputer in place of a desk top calculator may solve this problem.

(3) The unit tested had a maximum reading rate of 8 points per second. A rate of at least 16 points per second is required. It is understood that this higher rate is relatively easy to obtain since the device makes 64 readings per second internally.

(4) The unit tested had no method for time coordination. Each position reading must be time tagged to within 2 ms of a Central Range Time (IRIG). It may be sufficient to synchronize the internal clock of LAS II to Central Range Time.

## 7. RECOMMENDATIONS

The feasibility of using LAS II for air defense testing has been established using fixed ground points. It is recommended that further testing be conducted to evaluate LAS II performance during a continuous flight profile. The following steps are recommended:

a. Modify a LAS II to meet MAP compatibility requirements outlined in paragraph 6c.

b. Mount the LAS II in a helicopter which has a cooperative target for laser tracking and a transponder beacon for enhanced radar tracking. Test first using several high accuracy ground survey control points. It is recommended that this phase be conducted at White Sands Missile Range which has a high density of survey control points with the required accuracy.

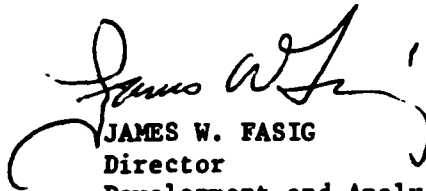
c. Then fly several flight profiles during which the aircraft location is measured by the LAS II, a laser tracker, and a radar (beacon track and skin track). The aircraft will also be tracked by SGT YORK.

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d. Process the target location tapes using the MAP and compare predicted tracking error and theoretical miss distances computed using LAS II, the laser tracker, and radar tracker.

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